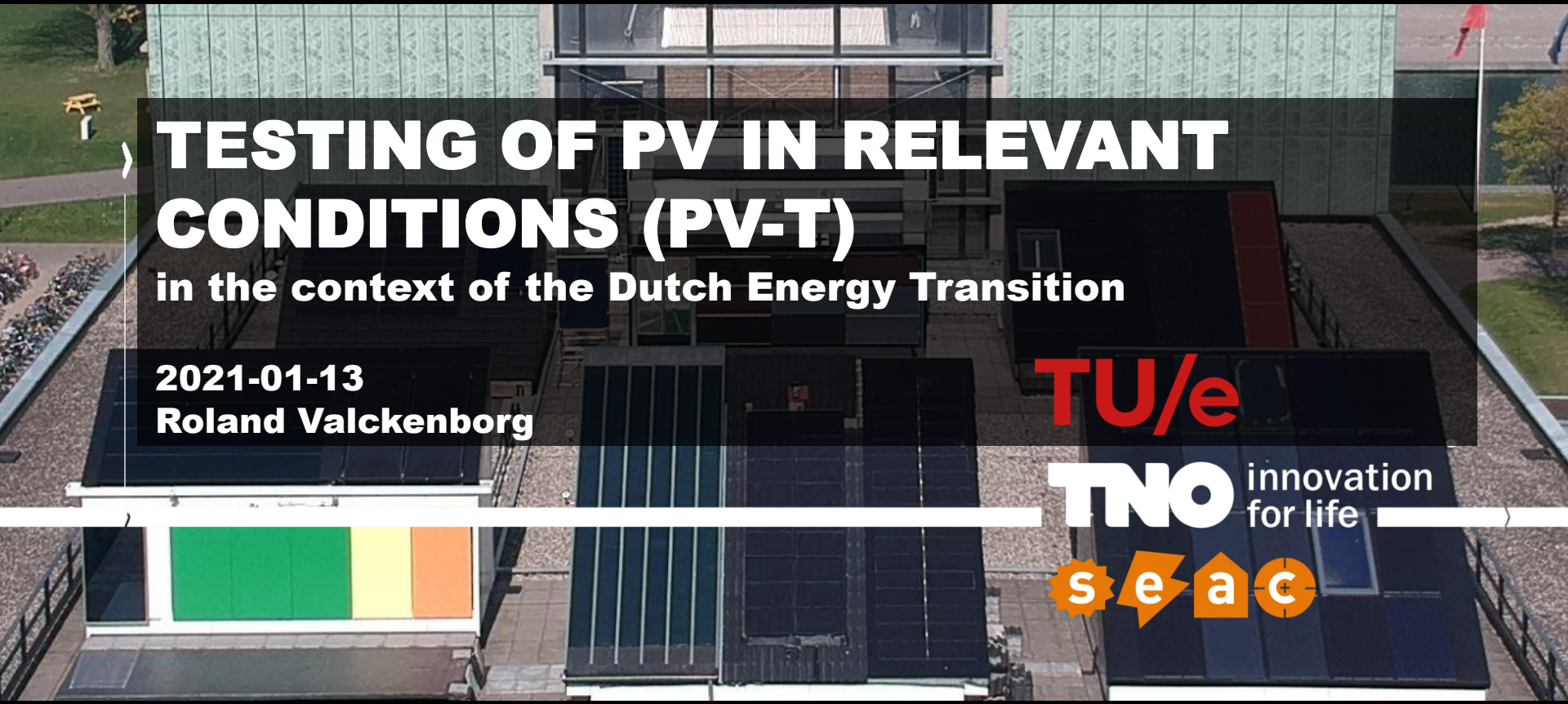

TESTING OF PV IN RELEVANT CONDITIONS (PV-T)

in the context of the Dutch Energy Transition

2021-01-13

Roland Valckenborg

TU/e

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A very brief history of the Dutch Energy Transition

RECENT ENERGY HISTORY IN NETHERLANDS

September 2013: Energy Agreement

- Bottom-up approach
- 47 organizations (NGO's, governmental bodies, industrial associations, environmental institutes) signed this agreement

Ambitions:

- Reduction of energy usage of 1.5% /year
- Per 2020, a total of 100 PJ (27 TWh) energy savings
- RE production target 14% in 2020 and 16% in 2023
- Employment of + 15,000 FTE

PARIS CLIMATE AGREEMENT

UNITED NATIONS
PARIS CLIMATE AGREEMENT
SIGNING CEREMONY
22 APRIL 2016

DUTCH EARTHQUAKES DUE TO GAS EXTRACTION

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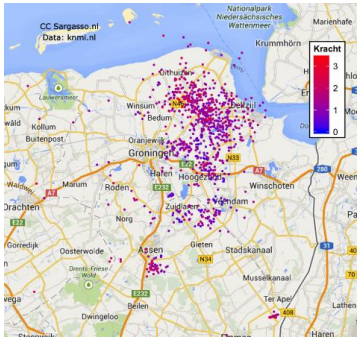
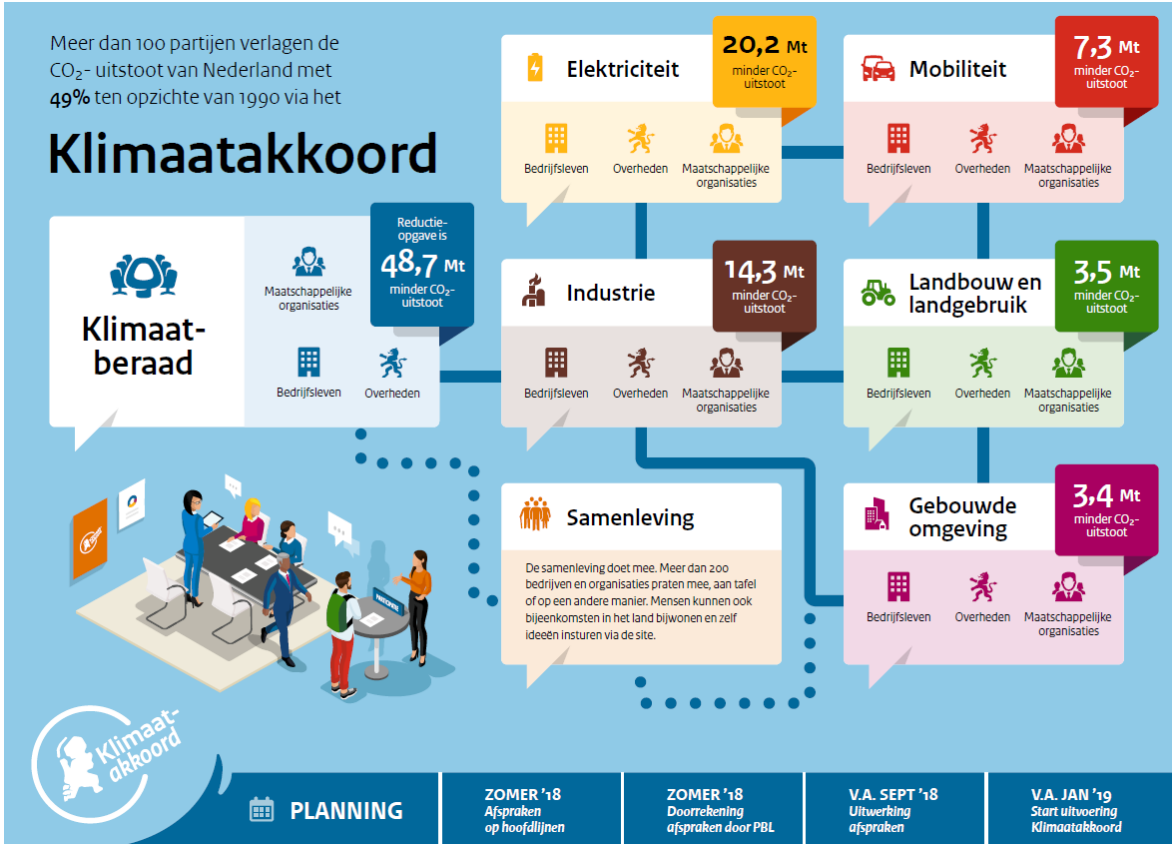


CLIMATE AGREEMENT PROCESS

June 2017: Climate law



- Top-down approach
- Paris → EU-goals → Dutch goals:
  - 49% less CO2-emissions in 2030 (w.r.t.1990)
  - 95% less CO2-emissions in 2050 (w.r.t. 1990)
- More than 100 organizations negotiating in structure with 5 tables (see on infographic)
- Implementation throughout a Climate Agreement

CLIMATE AGREEMENT

28th June 2019: Climate Agreement

- 600 concrete agreements
- 4 ministries involved
- Full text available in Dutch and English: www.klimaatakkoord.nl
- Concrete goals for 2030 and for 2050
- Zoom in some targets for 2030:
  - 1.5 million renovated houses (out of the 7 million total stock). Municipalities appoint these houses; deadline 2021
  - 35 TWh/year Renewable Energy production on land
  - 7 TWh/year additional Solar PV attached to buildings (BIPV & BAPV)

HOW MUCH PV SHORT TERM (2030)?

via process of a **RES=Regional Energy Strategy** with deadlines:

- October 2020: concept-RES
- June 2021: final RES document 1.0

The sum of PV and wind-on-land in all 30 concept-RES agreements is:

- around 50 TWh/year
- of which **25 GWp PV is planned**

on large roofs and parking areas; this is excluding all residential PV (with a 7 TWh/year target by law)

WHERE DO WE PUT SUCH A HUGE AMOUNT OF PV IN THE TINY COUNTRY OF THE NETHERLANDS ?

MAP OF THE NETHERLANDS

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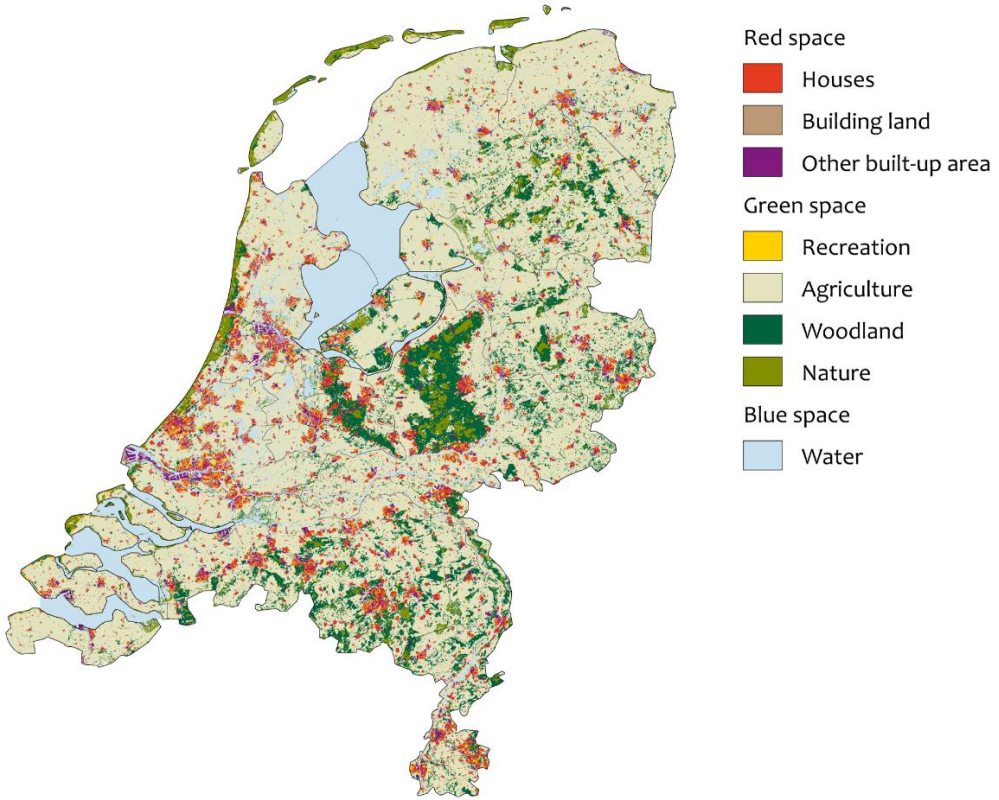
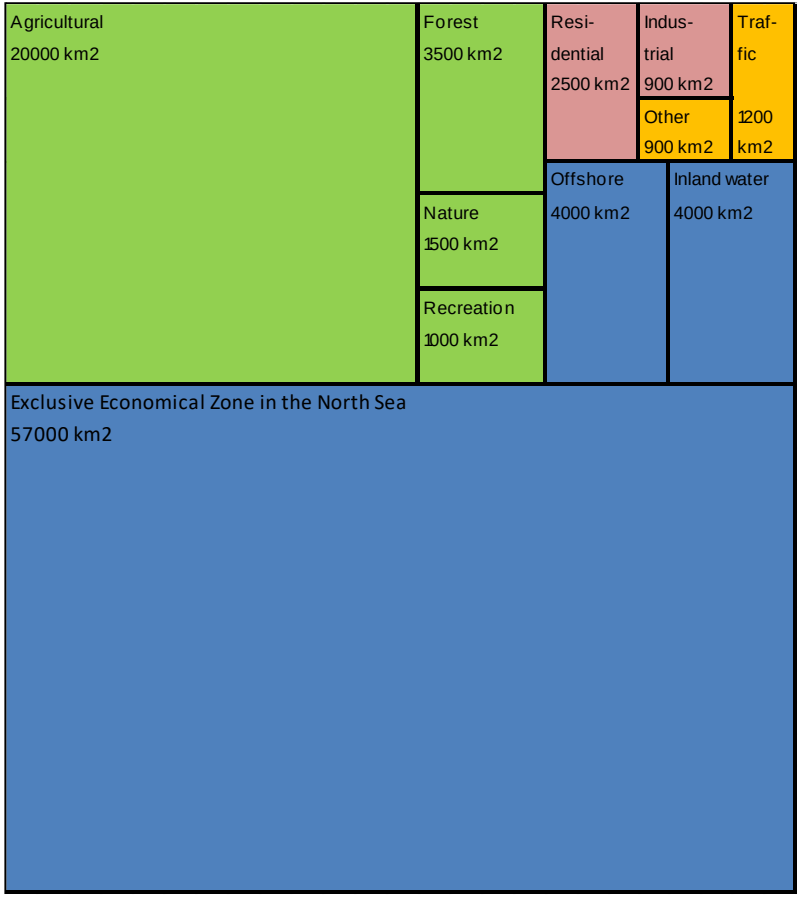
Land use in the Netherlands, 2012



Source: CBS, Land Registry.

CBS/jan16
www.clo.nl/en006110

SCHEMATIC MAP OF THE NETHERLANDS



- Presented in 2018 in roadmap 'PV systems & applications in the Netherlands'

https://www.uu.nl/sites/default/files/roadmap-pv-systemen-en-toepassingen-final.pdf

- Now, 2 years later, in the Netherlands, there is broad understanding of:
  - Produce (Renewable) Energy close-by the Usage of this Energy
  - Double function of area is mandatory
  - Optimizing only lowest LCOE for the project developer is not the best solution for the country
  - Societal participation needed for a solid support base (not only financial participation)

APPLICATION FIELDS OF SOLAR ENERGY

Classification into these 4 fields of solar applications is international and widely accepted:

- In & On Buildings 

- In & On Infrastructure 

- In & On Water 

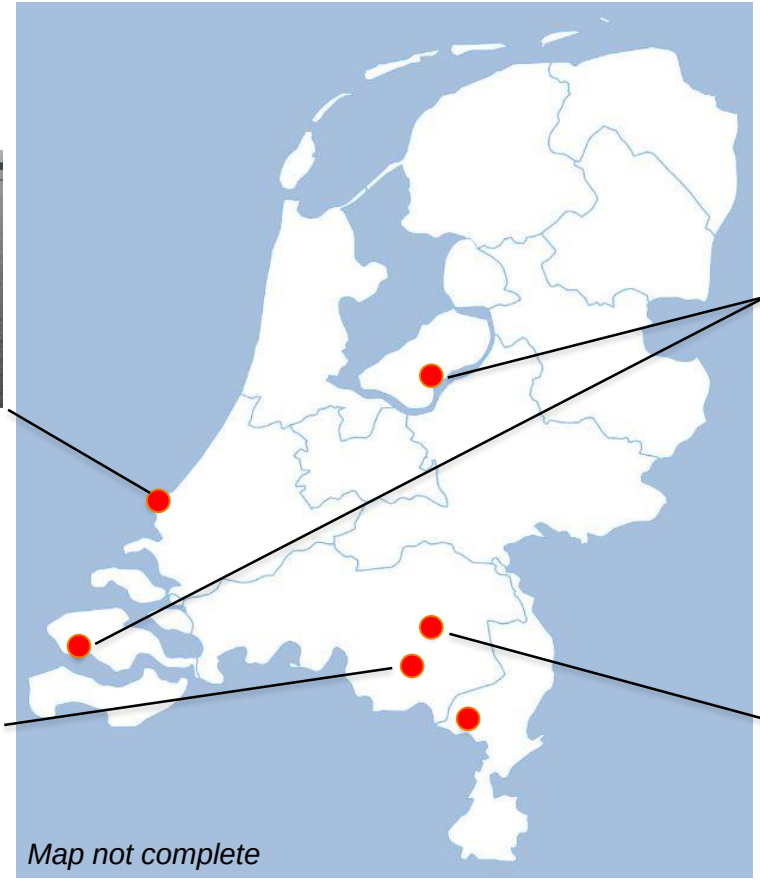
- In the landscape 

TU/e and TNO are very active in all 4 national consortia, because innovation is key.

OUTDOOR LABS

zon op water

zon op gebouw



zon in landschap

zon op infra

SOLARBEAT

2013: Kick-off. Official collaboration of TNO(SEAC) with TU/e.

2019: Six years of co-development within 21 projects with 86 companies (63 unique companies).

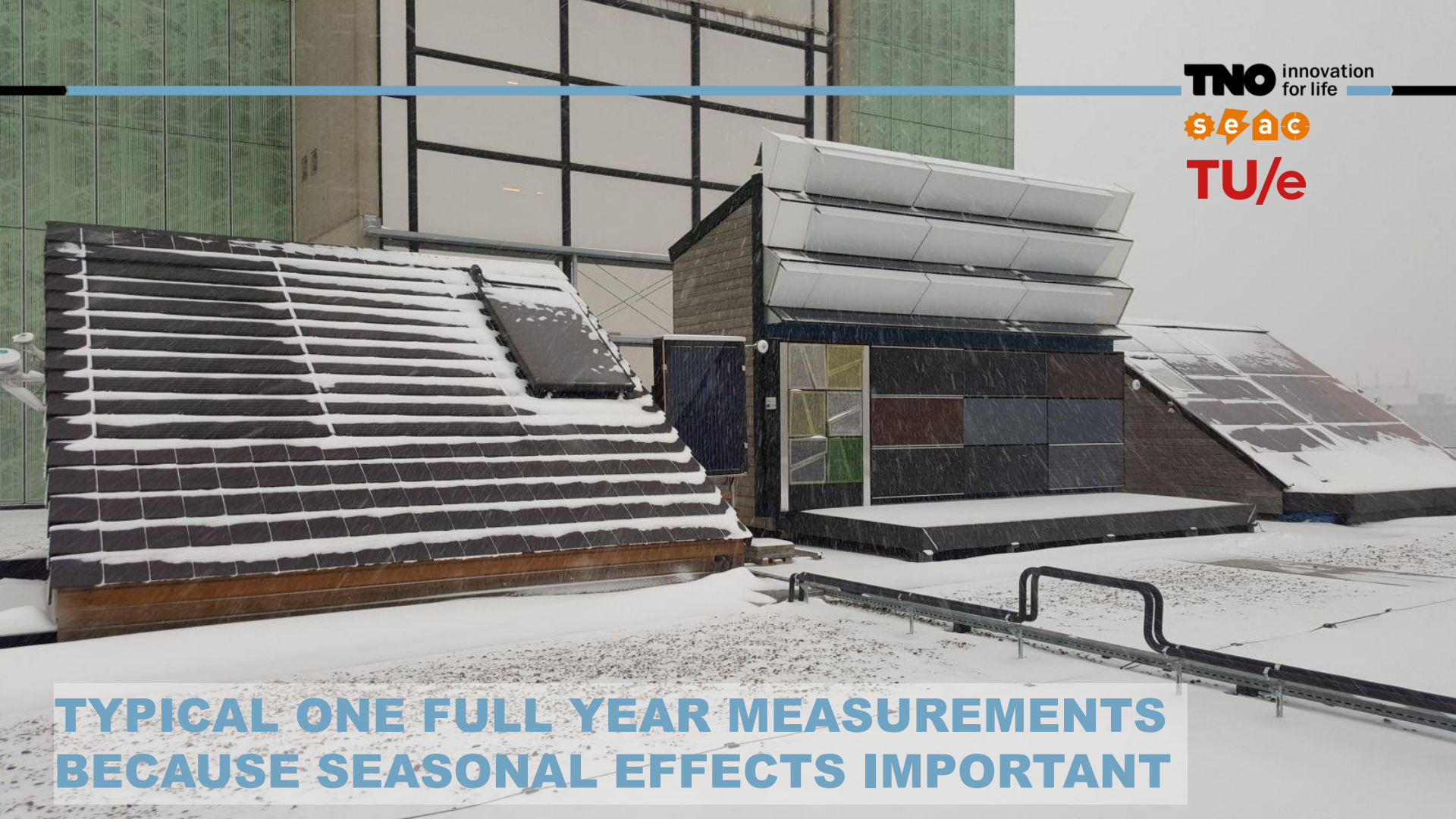
2020/2021: SolarBEAT moving more towards international projects with larger multinationals showing interest in BIPV.

SOLARBEAT RESEARCH & TESTING

Research topics:
- Building integration
- Electrical integration
- Performance testing as input for system modeling and validation
- Aesthetics

Technologies:
- Solar electricity (PV) all technologies: cSi, CdTe, CIGS, upcoming Perovsikes
- Solar thermal
- Combined (PVT)

Part of building skin:
- Flat roof
- Pitched roof
- Façade: opaque (cladding) and translucent (PV windows or IGU’s)
- Balcony



TYPICAL ONE FULL YEAR MEASUREMENTS BECAUSE SEASONAL EFFECTS IMPORTANT

PERFORMANCE TESTING = BIG DATA (?)

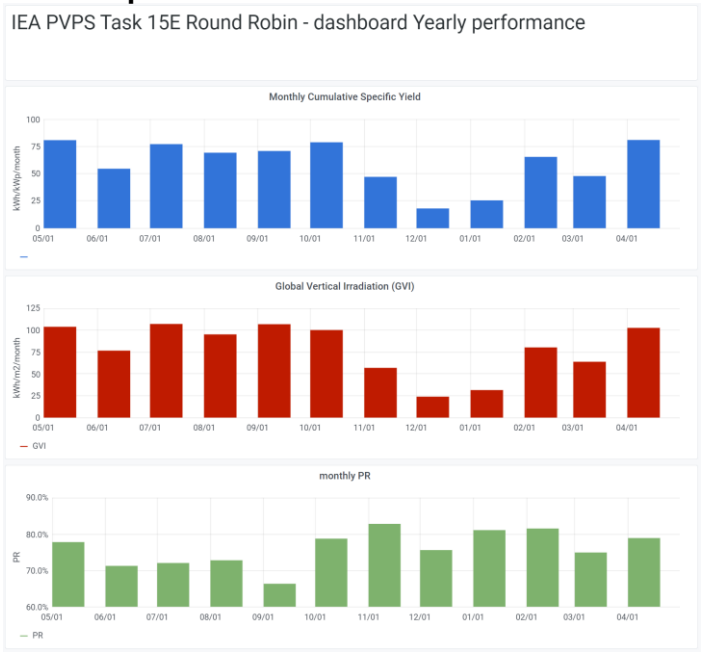
SolarBEAT (and other application test fields) <u>active data:</u>

- 40 databases
- 68 dataloggers
- >1500 sensors of
- 55 sensor classes (physics)
- 85 sensor types

- Resolution 1 minute (typical)
- More sampling when needed
- Always according to research plan

- Total: ≈ 2 million datapoints/day
- All synchronized to atomic time

Example:



COLORED BIPV GETTING TO A HIGHER LEVEL

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SOLAR THERMAL DETAILS

Solar Thermal (ST):
- Uncovered colored; see next slide
- Covered/Glazed colored; see other slide

Combined (BI)PVT:
- on top of eachother
- ST and PV side-by-side

Thermal system emulation:
- ‘Emulation’: User pattern as defined by standard is really applied by heatpump inside cabin
- Full year thermal performance testing
- Thermal storage testing

COLORED SOLAR THERMAL

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GLAZED COLORED SOLAR THERMAL

FULL ROOF SOLUTION

THANKS FOR YOUR ATTENTION !

Please contact me,
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